CHAPTER 1
INTRODUCTION

1-1. Purpose. This Design Guide provides practical guidance for the design of liquid and vapor phase devices for the adsorption of organic chemicals. The adsorptive media addressed include granular activated carbon (GAC) and other alternative adsorption carbon media, such as powdered activated carbon (PAC) and non-carbon adsorbents.

1-2. Scope. This document addresses various adsorption media types, applicability, use of various adsorption process technologies, equipment and ancillary component design, availability, advantages, disadvantages, regeneration methods, costs, and safety considerations. The equipment can be installed alone or as part of an overall treatment train, based on site-specific factors.

1-3. Background.

a. Carbon, in various forms, has been used to adsorb contaminants for some time. The first documented use of carbon as an adsorbent was for medical purposes, in the form of wood char in 1550 B.C. The first documented use for water treatment was in 200 B.C. “to remove disagreeable tastes.” In 1785 experimental chemists learned that carbon could accumulate unwanted contaminants from water. Carbon in the activated form was first used as a filter medium in the late 1800s. The understanding of carbon adsorption progressed in the late 19th and early 20th centuries, when vapor phase organic carbon was developed and given its first widespread use as a defense against gas warfare during WWI.

b. The first GAC filters used for water treatment were installed in Europe in 1929. The first GAC filters for water treatment in the United States were installed in Bay City, Michigan, in 1930. In the 1940s, GAC was found to be an efficient purification and separation technology for the synthetic chemical industry. By the late 1960s and early 1970s, GAC was found to be very effective at removing a broad spectrum of synthetic chemicals from water and gases (i.e., from the vapor phase).

1-4. Abbreviations and Acronyms.

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BDST	bed depth service time
BET	the Brunauer, Emmett, and Teller equation
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFCs	chlorofluorocarbons

CFR	Code of Federal Regulations
COC	contaminant of concern
COD	chemical oxygen demand
COH	COH Corporation, Inc.
CORECO	College Research Corporation
CRSI	Continental Remediation Systems, Inc.
DB	divinyl benzene
DG	design guide
EBCT	empty bed contact time
EPA	United States Environmental Protection Agency
GAC	granular activated carbon
HPMC	high pressure minicolumn
HTRW	hazardous, toxic, and radiological waste
MCACES	Micro Computer Aided Cost Estimating System
MEK	methyl ethyl ketone
MIBK	methyl isobutyl ketone
MSDS	material safety data sheet
MTZ	mass transfer zone
NFPA	National Fire Protection Association
NRMRL	National Risk Management Research Laboratory
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
PAC	powdered activated carbon
PACS	Professional Analytical and Consulting Services, Inc.
PCE	perchloroethene
pH	inverse log of hydrogen ion concentration
ppm	parts per million
PSD	particle size distribution
RA	remedial action
RACER	Remedial Action Cost Engineering and RequirementsSystem
RCRA	Resource Conservation Recovery Act
RH	relative humidity
RREL	Risk Reduction Engineering Lab
SVE	soil vapor extraction
SVOC	semivolatile organic compounds
TCE	trichloroethene
TCLP	toxic characteristics leaching procedure
TSDF	treatment storage or disposal facility
USACE	United States Army Corps of Engineers
USAF	United States Air Force
VOC	volatile organic compounds
WBS	work breakdown structure